Academia Europaea
The Academy of Europe

Valedictory Presidential Lecture

Professor Sierd Cloetingh MAE

“Europe: Natural Laboratory for Frontier Research in Earth Sciences”

Friday 10 December 2021
16.15 - 17.15

Large Lecture Hall
Hungarian Academy of Sciences
Budapest

The lecture will be streamed live on the youtube channel of the Hungarian Academy of Sciences (https://www.youtube.com/c/MTA1825). Once the lecture starts, just click on the video with a „LIVE“ tab on it, or find the „Live“ channel in the menu and select the lecture.
TITLE AND FULL NAME: Professor Dr. Sierd Cloetingh

AFFILIATION: Utrecht University, Department of Earth Sciences

LINK TO WEBPAGES: http://www.ae-info.org/ae/Member/Cloetingh_Sierd
https://www.uu.nl/staff/SAPLCloetingh

TITLE OF PRESENTATION: Europe: Natural Laboratory for Frontier Research in Earth Sciences

ABSTRACT OF PRESENTATION:
Integrated studies of the full Earth system across space and time scales are rapidly advancing. The International Lithosphere Program (ILP), connecting geophysical and geological sciences at their interfaces, promotes frontier research in Solid-Earth science, with high societal impact in the domains of geoenvironment, geohazards and geo-resources. Probably one of the important developments in Solid-Earth science over the past decade has been the recognition of the importance of linking deep Earth dynamic processes with surface and near-surface geologic processes (e.g., Cloetingh and TOPO-EUROPE Team, 2007, Global and Planetary Change; Cloetingh et al., 2013, Tectonophysics; Cloetingh, 2020, Encyclopaedia of Solid Earth Geophysics). Deep Earth research, encompassing fields such as seismology and mantle geodynamics, has traditionally operated distinctly from fields focusing on dynamics near the Earth's surface, such as sedimentary geology, geomorphology, and climate/paleoclimate. However, as realized by ILP, these endeavours have in common the study of Earth’s topography and the prediction of its origin and rates of change. Observations from surface studies, such as basin stratigraphy, geomorphology of landscapes, changes in surface elevation, and changes in sea level (Cloetingh and Haq, 2015, Science), provide some of the principal constraints on geodynamic and tectonic models. Conversely, deep geodynamic processes give rise to topography, thereby modifying regional climate, erosion, and sediment generation that are the basis of surface geology. The lithosphere, due to its stratified rheological structure, acts as a non-linear “filter” for deeper sources, attenuating long deformation wavelength and creating new, shorter wavelength deformation; giving a surface response more complex than that of the mantle source. It is the surface manifestations of these deep geodynamic processes modified by mantle-lithosphere interactions that have significant societal impact by (1) creating natural hazards, such as earthquakes and mass movements, and (2) controlling the distribution of natural resources including fossil fuels and geothermal energy. The relevance of research conducted in both the deep Earth and surface regimes is thus strongly enhanced through a focus on their interaction. Long-term inner Earth processes, such as mantle flow, drive the system of mantle-surface interaction. However, short-term outer Earth processes such as erosion and climate tune the response. The continental lithosphere transforms deformation generated at its base by mantle flow, but surface processes control many of the observables such as topography, sedimentation and exhumation rates, and thus further filter the source and even tune the response through cyclic processes such as climate. However, little is known on how far these interactions may go, or how these different processes are coupled or feed back into the dynamic system. At the same time, many modelling or theoretical studies suggest that erosion and sedimentation do impact the
subsurface evolution of crustal deformation, changing flow patterns and magnitudes in the ductile crust and mantle through changing gravitational stresses or kinematics.

Europe through its well-studied natural laboratories, such as the Northwestern European Atlantic continental margin and the Pannonian Basin-Carpathian Mountain system of Central and Eastern Europe, is an excellent place to further advance insights in the interaction of deep Earth and surface processes. The high level of integrated solid Earth science, the existence of platforms for community building, such as Academia Europaea, TOPO-EUROPE and the European Plate Observing System EPOS are also crucial in this respect. This provides a solid foundation to connect frontier science and societal relevance in the domains of geo-energy and natural hazards on a full pan-European scale. The science base in Europe is now rapidly developing to bring geothermal energy into power in plate interiors, significantly enhancing its contribution to the energy transition in Europe and elsewhere.

Figure 1. (Cloetingh, 2020) Tomographic cross-sections for the upper mantle below Europe, illustrating heterogeneity in the upper mantle. Depth scale is 600 km. The blue and red colours correspond to areas where seismic P-wave velocities are respectively higher and lower than the standard reference velocity model. The sections display distinct patterns of down-going slabs in convergent zones of Europe overlain by lithosphere with reduced seismic velocities, corresponding with areas of high heat flow and high potential for geothermal energy exploration. The overall topography of Europe, depicted in the central panel, is characterised by elevated areas (including the Alps, Dinarides, Apennines, Carpathians, Pyrenees and the Anatolian Plateau) not only in the convergent settings, but also in intraplate settings such as Iberia (Tomographic sections: courtesy W. Spakman)
BIOGRAPHICAL NOTE:
Sierd Cloetingh is Utrecht University Distinguished Professor. His research field is Earth Sciences. He published 376 papers in international peer-reviewed journals (Scopus: 17,523 citations, h-index 73) and has been promotor of close to 80 PhD students of 18 different nationalities. Currently he serves as President of the Academia Europaea, Member of the Board of SAPEA (Scientific Advice for Policy by European Academies) and Chair Coordinating Committee Europe of the International Lithosphere Program. Past functions include President of the Association for European Cooperation in Science & Technology (COST), Membership of the Scientific Council (2009-2015) and Vice-President of the European Research Council (ERC), President of the European Geophysical Society (1998-2000), President of the International Lithosphere Program (ILP), Distinguished Professor of the Royal Netherlands Academy for Arts and Sciences (KNAW, 2006-2015), Editor-in-Chief of the international journal "Global and Planetary Change" and Chairman of the ESF TOPO-EUROPE large-scale European collaborative research program.
Sierd Cloetingh received honorary doctorates from five European universities and numerous medals and awards. He is member of the Royal Netherlands Academy of Sciences and the German National Academy for Technical Sciences (acatech), Foreign member of the Royal Norwegian Academy, Royal Danish Academy, Heidelberg Academy, Bavarian Academy of Sciences and honorary member of the Hungarian Academy of Sciences. He was distinguished in 2005 as Chevalier de Legion d'Honneur and in 2014 as Knight of the Royal Order of the Netherlands Lion for his contributions to science and European scientific cooperation in research and education.